CLAIMS

1. A method of automatic frequency control of gaussian minimum shift key (GMSK) modulated signals transmitted over time-dispersive channels, the method comprising the steps of:

(a) receiving a GMSK modulated signal having a voice/data signal minimum shift key (MSK) modulated in time slots of a carrier signal;

(b) for each time slot, utilizing a mixing signal to demodulate at least part of the voice/data signal from the carrier signal;

(c) converting a plurality of amplitude and phases of the demodulated voice/data signal into a like plurality of received quadrature data;

(d) determining from the plurality of received quadrature data a frequency error slope value, a binary cyclical redundancy check (CRC) value, an average signal-to-noise ratio (SNR) value, a received signal strength indicator (RSSI) value, and a sequence of digital bits forming at least part of the voice/data signal;

(e) weighting the frequency slope error value with a first weighting value or a second weighting value when the binary CRC value is in a first binary state or a second binary state, respectively, to produce a weighted frequency slope error value, with the first weighting value including the combination of the average SNR value and the RSSI value, with the second weighting value zeroing the frequency slope error value;

(f) determining an average weighted frequency slope error value for a plurality of time slots of the carrier signal;

(g) determining an average weighting value from the first weighting value and/or the second weighting value for the plurality of time slots;

(h) combining the averages determined in step (f) and step (g) to obtain an unweighted frequency error value; and

(i) adjusting a frequency of the mixing signal as a function of the unweighted frequency error value.

2. The method as set forth in claim 1, wherein:

the average SNR value is obtained by averaging a plurality of SNR values;

each SNR value is determined from a comparison of a best estimate of a corresponding one of each received quadrature data with one of a plurality of ideal quadrature states; and

the best estimate of each received quadrature data is determined by filtering each received quadrature data for noise and correcting each received quadrature data for multi-path distortion.

3. The method as set forth in claim 1, wherein the RSSI value is determined by combining at least part of the plurality of received quadrature data.

4. The method as set forth in claim 1, wherein the binary CRC value is in the first binary state or the second binary state when a respective match or difference is detected between a reference CRC value and a combination at least part of the sequence of digital bits.

5. The method as set forth in claim 1, wherein each frequency error slope value is determined by combining a best estimate of each quadrature data with an ideal quadrature data corresponding to at least one digital bit in the sequence of digital bits, where the best estimate of each quadrature data is determined by filtering each received quadrature data for noise and correcting each received quadrature data for multi-path distortion.

6. The method as set forth in claim 1, further including the steps of:

(j) storing an unweighted frequency slope value;

(k) after step (j), detecting when the average determined in step (g) is zero; and

(l) in response to detecting when the average determined in step (g) is zero, adjusting the frequency of the mixing signal as a function of the stored unweighted frequency error value.

7. The method as set forth in claim 1, wherein determining the frequency error slope value in step (d) includes the steps of:

(d1) MSK modulating each bit of the sequence of digital bits to obtain ideal quadrature data equivalents thereof;

(d2) filtering each quadrature data for noise and correcting each received quadrature data for multi-path distortion to obtain a best estimate for each received quadrature data;

(d3) determining a complex conjugate of the best estimate of each received quadrature data;

(d4) combining each complex conjugate with its temporally corresponding ideal quadrature data equivalent to obtain a corresponding frequency error quadrature data;

(d5) determining an arctangent value of each frequency error quadrature data;

(d6) storing each arctangent value; and

(d7) determining the frequency error slope value from the stored arctangent values.

8. The method as set forth in claim 7, wherein:

step (d6) includes storing each arctangent value in time order; and

step (d7) includes utilizing a linear curve fitting algorithm to process the stored arctangent values to obtain the frequency error slope value.